

Article

New Energy Demonstration City Construction and Corporate Energy Consumption: Evidence from China's A-Share Listed Companies

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Abstract

This study examines the causal impact of China's New Energy Demonstration City construction policy on corporate energy consumption. The results demonstrate that this policy effectively reduces corporate energy consumption. The policy significantly decreases the consumption of coal, natural gas, and diesel. Although the policy significantly reduces energy consumption in both local state-owned enterprises (SOEs) and non-SOEs, its effect does not show statistically significant variation across different types of controlling shareholders. The energy-saving effect is particularly pronounced in the following industries: Manufacturing, Electricity, Heat, Gas, and Water Production & Supply, Wholesale & Retail Trade, Information Technology Services, Leasing & Business Services, and Water Conservancy, Environment, and Public Infrastructure Management. The policy operates through multiple channels: internal mechanisms including direct innovation effect, accelerated green M&As effect as well as digital empowerment effect, and external moderators including marketization level and green finance environment. The findings yield important insights for scholars, policymakers and corporate stakeholders.

Keywords: new energy demonstration city construction (NEDCC); energy consumption; listed companies; difference-differences model; influence mechanism



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1. Introduction

In the global strategy to address climate change, energy conservation and emission reduction have emerged as pivotal policy measures adopted by nations worldwide. As the corporate sector accounts for most global energy consumption and carbon emissions [1], corporate energy-saving behaviors have consequently become the focal point of these mitigation efforts. Extant literature has identified multiple determinants affecting corporate energy consumption, including but not limited to board gender diversity [2], artificial intelligence applications [3], climate risk perception [4], green finance initiatives [5,6], digital transformation [7], greenwashing practices [8], and digital empowerment strategies [9].

Among these interventions, environmental regulations—those aligned with the Porter Hypothesis—have been recognized as one of the most effective mechanisms for reducing energy consumption. This is evidenced by globally implemented policy instruments such as emission trading scheme [10] and carbon tax [11]. In contrast to these mandatory environmental regulations, less stringent policy alternatives exist, like China's New Energy Demonstration City construction (NEDCC) program. The NEDCC initiative represents a

distinctive urban policy that promotes the utilization of local renewable energy resources (e.g., solar, wind, geothermal, and biomass energy) to achieve significant proportions of renewable energy in urban consumption [5,12]. While theoretically posited to influence corporate energy consumption patterns, the regulatory effects of this policy instrument and its underlying mechanisms remain insufficiently examined in the current literature. This research gap warrants systematic investigation to elucidate the policy's actual efficacy and operational pathways.

The scientific community has extensively examined the downstream effects of NEDCC initiatives, particularly at the urban level. Notably, existing research has predominantly focused on urban-level impacts, including carbon mitigation [12–14], energy efficiency improvements [5,15,16], energy transition acceleration [17,18], green economic growth [19–21], pollution abatement [22–24], renewable energy technology development [25,26], green innovation diffusion [27], and new quality productivity growth [28]. However, the micro-level effects on corporate entities remain underexplored. Two exceptions merit attention: Liu et al. identified significant reductions in corporate energy intensity through tax incentives and technological innovation pathways [29]; He et al. established technological innovation as the key mechanism for enhancing total-factor energy efficiency in energy-intensive enterprises [30].

Despite growing scholarly attention, several critical gaps remain in understanding the firm-level impacts of NEDCC policies. Firstly, existing studies have not systematically examined how NEDCC policies affect firms' total energy consumption and, more importantly, the heterogeneous effects across different energy types (e.g., coal, natural gas, diesel, electricity). Secondly, while prior work acknowledges technological innovation as a driver of energy efficiency, the specific role of green innovation—a more targeted and policy-relevant mechanism—remains underexplored [26]. Does the NEDCC policy primarily incentivize green technological advancements, thereby reducing corporate energy consumption? Beyond innovation, firms may adopt other green or digital strategies to comply with NEDCC policies, such as green mergers and acquisitions (M&As) [31] and digital transformation [9]. However, empirical evidence on these behavioral responses is scarce. Thirdly, given China's unique institutional context, state-owned enterprises and private firms may respond differently to NEDCC policies due to divergent governance and operational incentives [32]. Also, energy-intensive sectors (e.g., manufacturing, utilities) may exhibit stronger policy sensitivity than less energy-dependent industries. However, these potential heterogeneous effects remain unknown. Finally, firms do not operate in isolation—external institutional and market conditions (e.g., regional marketization, green finance development) may amplify or weaken policy effectiveness. Yet, the interplay between NEDCC policies and these external factors remains unclear.

To address these gaps, this study constructs a novel firm-level panel dataset of Chinese A-share listed firms and employs rigorous econometric methods to investigate the following research questions:

RQ1: Does the NEDCC policy significantly reduce corporate energy consumption, and how does its effect vary across different energy types?

RQ2: Are the policy's effects consistent across firms with different ownership structures and industry characteristics? What internal mechanisms (e.g., green innovation, digital transformation, green M&As) mediate these effects?

RQ3: How do external environmental factors (e.g., marketization level, green finance development) moderate the policy's impact on corporate energy consumption?

By addressing these questions, this study contributes to literature in the following ways. Firstly, this study establishes its theoretical foundation on an integrated framework combining Porter Hypothesis, institutional theory, and the technology acceptance model

(TAM) to systematically examine the energy reduction effects of NEDCC policies from a micro-level perspective. Building upon the Porter Hypothesis, we posit that properly designed environmental regulations can stimulate innovation and ultimately enhance corporate competitiveness while reducing energy consumption. The institutional theory lens helps explain how coercive, normative, and mimetic pressures from NEDCC policies shape corporate energy behaviors. Furthermore, we incorporate TAM to understand how firms' perceived usefulness and ease of adopting green technologies influence their response to policy mandates. Also, we extend the theoretical boundaries by introducing transaction cost theory, which suggests that the Porter effect's realization is contingent on external environmental factors that may affect policy implementation costs. This theoretical integration allows us to comprehensively investigate both internal and external mechanisms through which NEDCC policies influence corporate energy consumption patterns.

Secondly, the current research paradigm establishes a robust analytical framework consisting of baseline analysis of policy effects, heterogeneity examination across firm types and industries, dual-channel mechanism analysis encompassing internal pathways (green technology innovation, green M&As, digital transformation) and external moderators (marketization level, green finance development). This framework effectively demystifies the "black box" between NEDCC policies and corporate energy consumption, providing valuable theoretical insights for similar studies and policy optimization regarding corporate energy conservation.

Thirdly, the study makes significant empirical contributions through its novel dataset construction. We computed comprehensive energy consumption indicators from corporate annual reports and CSR reports and disaggregated energy use by type. We also developed text-based indicators using keyword search-pairing-aggregation methods to measure digital transformation by extracting data from annual reports and financial statements. In addition, we constructed green M&As database from corporate announcements and compiled green patent data from patent application texts. We quantified regional marketization levels using city statistical data and assessed green finance development through regional financial indicators. This meticulously constructed firm-level panel dataset represents a significant advancement in environmental regulation research, offering a comprehensive framework for assessing policy impacts on corporate energy behaviors. The dataset's multidimensional nature enables robust analysis of both direct policy effects and contextual moderators, setting a new standard for micro-level environmental policy evaluation.

2. Literature Review and Theoretical Background

The NEDCC policy represents an urban-level environmental regulation implemented to achieve climate action goals, characterized as a weak-constraint policy instrument [13]. This initiative encourages pilot cities to explore renewable energy technologies across urban power supply, heating systems, and building energy efficiency, thereby reducing fossil fuel dependence and increasing renewable energy penetration in urban energy consumption. The policy evaluation framework comprises three key indicators: (1) total renewable energy utilization, (2) categorized renewable energy applications, and (3) organizational management with incentive policies. Notably, unlike mandatory environmental regulations with specific compliance targets, the NEDCC policy delegates authority to local governments for setting implementation standards, including energy consumption thresholds and sector-specific requirements [19]. This decentralized approach represents an exploratory governance experiment in environmental regulation. While existing studies have extensively examined various impacts of the NEDCC policy [15,20,22], its effectiveness in inducing corporate energy reduction remains empirically unverified. Aligned with the policy's original intent, this study proposes

H1. *The NEDCC policy implementation significantly reduces corporate energy consumption.*

The impact of the NEDCC policy on corporate energy consumption may exhibit significant heterogeneity based on ownership structure. State-owned enterprises (SOEs) and non-SOEs demonstrate distinct characteristics in energy consumption patterns. SOEs, typically large-scale entities in traditional industries, often maintain established high-pollution production pathways, creating substantial path dependence in energy transition [33]. Their implicit political connections [34] may further weaken policy effectiveness. In contrast, non-SOEs (primarily private firms) demonstrate greater adaptability to policy pressures through operational and R&D adjustments, as market competition compels them to offset environmental compliance costs through productivity gains [35]. This competitive dynamic enhances their energy efficiency responsiveness to the NEDCC policy.

The policy's effectiveness also varies across industries with different energy intensity. The NEDCC implementation framework follows a "government support, corporate responsibility, market operation, multi-party participation" principle, particularly targeting energy-intensive sectors through mandatory phase-out of backward production capacity, strict energy consumption limits for high-energy products, and rigorous approval standards for new projects in high-emission industries [29]. These measures substantially increase production and compliance costs for energy-intensive firms, forcing technological innovation as a survival strategy [30]. Conversely, low-energy-intensity and cleaner industries face weaker regulatory pressure, resulting in more modest energy reduction effects. Based on these analyses, this study hypothesizes

H2. *The NEDCC policy's impact on energy consumption varies by firm type, with stronger effects observed for non-SOEs and energy-intensive enterprises compared to SOEs and low-energy-intensity firms.*

The NEDCC policy implementation aims to enhance energy efficiency and promote renewable energy adoption, thereby facilitating energy conservation in production processes and driving industrial transition toward low-carbon development. This transition inherently requires corporate technological innovation, particularly in green technologies, as firms upgrade existing systems to meet renewable energy utilization and energy reduction requirements—a manifestation of the Porter Hypothesis. Well-designed environmental regulations can generate innovation offsets that improve production efficiency while delivering economic benefits [36]. The Porter Hypothesis posits that appropriate regulatory pressure creates incentives for innovation in green technology, leading to enhanced energy use efficiency, reduced production-related energy emissions, achievement of regulatory compliance targets, and realization of dual environmental-economic benefits. This theoretical framework suggests the following innovation channel:

H3. *The NEDCC policy implementation reduces corporate energy consumption through promoting green technology innovation.*

Green M&As serve as a critical mechanism for firms to rapidly acquire heterogeneous resources, particularly clean technologies and energy efficiency management capabilities [37,38]. By integrating target companies' patented technologies (e.g., photovoltaic and energy storage systems) and consolidating R&D resources, firms can accelerate green technology breakthroughs [39,40], thereby directly enhancing energy efficiency and reducing consumption. Institutional theory [41] provides a framework for understanding how the NEDCC policy influences corporate green M&As decisions through three institutional pressures: Coercive Pressure, Normative Pressure, and Mimetic Pressure. Concretely, the

policy establishes mandatory environmental standards and energy efficiency requirements, compelling firms to acquire green technologies through M&As to achieve compliance. By promoting sustainable development principles, the policy creates industry norms that incentivize firms to pursue green M&As for competitive advantage and social legitimacy. In addition, through public awareness campaigns, the policy fosters environmental consciousness, encouraging firms to demonstrate ecological commitment via green M&As activities. This theoretical foundation leads to our fourth hypothesis:

H4. *The NEDCC policy implementation accelerates corporate energy consumption reduction by facilitating green M&As activities.*

Digital transformation represents a fundamental organizational capability for resource reconfiguration (e.g., data assets, intelligent algorithms) to address energy challenges. Through technological empowerment effects, it enhances energy management efficiency and significantly reduces corporate energy consumption [7,9]. The TAM provides a theoretical framework for understanding this process, positing that technology adoption depends on two core factors [42]: perceived usefulness and perceived ease of use. The NEDCC policy enhances this perception through financial subsidies, tax incentives, and market access privileges. These measures reduce transformation costs while increasing expected benefits. The policy improves perceived ease of use by developing 5G networks, data centers, smart grid infrastructure. Such infrastructure lowers technical barriers to adoption. This dual mechanism leads to the fifth hypothesis:

H5. *The NEDCC policy implementation reduces corporate energy consumption through facilitating comprehensive digital transformation.*

Challenging the universal applicability of the Porter Hypothesis, Williamson's transaction cost economics argues that environmental regulation's innovation effects are contingent on institutional environments [43]. The theory posits that real-world transaction costs may substantially weaken or even reverse the Porter effect. This critique stems from two fundamental observations. One is that the strong Porter Hypothesis implicitly assumes policymakers can design perfect contracts. However, real-world regulations like the NEDCC policy contain inherent ambiguities. Another is that non-mandatory constraint mechanisms possess flexible entry and exit criteria. These features may enable strategic avoidance and ceremonial adoption [44], where firms perform superficial compliance without substantive changes. Therefore, transaction cost economics emphasizes how external market conditions mediate policy effectiveness. Specifically, higher marketization reduces transaction costs in policy implementation and developed financial systems lower innovation adoption barriers. This theoretical perspective suggests the market environment's moderating role in realizing the Porter effect. Therefore, this study proposes the final hypothesis:

H6. *The NEDCC policy's energy reduction effect is positively moderated by favorable market conditions, with stronger impacts observed in regions with higher marketization levels and better financial support.*

In sum, the study's theoretical framework is conceptually illustrated in Figure 1.

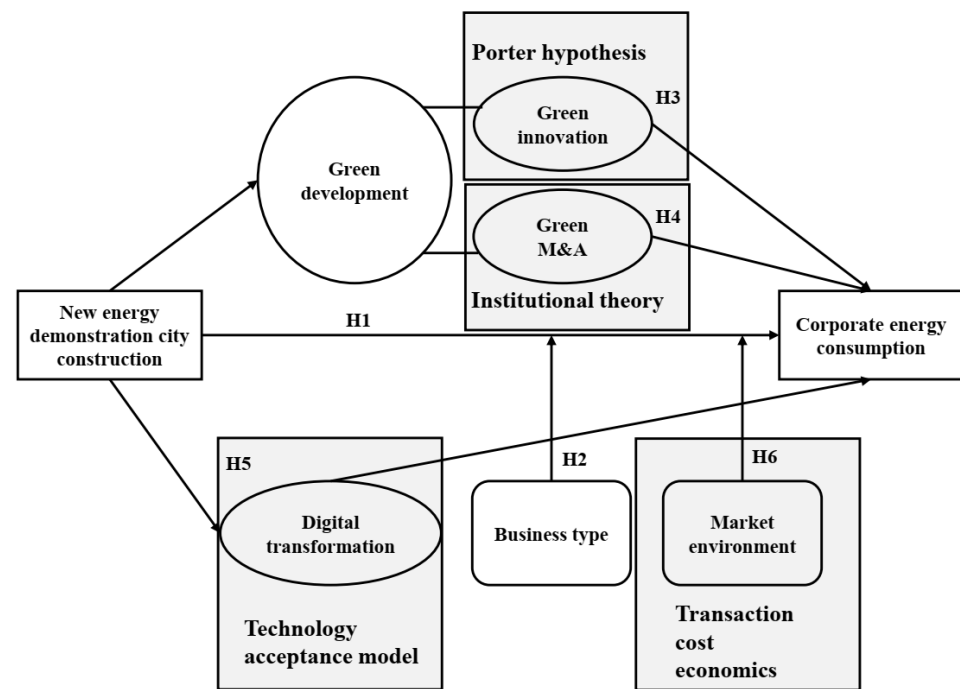


Figure 1. Theoretical framework.

3. Methodologies

This study employs a difference-in-differences (DID) model with fixed effects to estimate the policy impact:

$$energy_{it} = \beta_0 + \beta_1 DID_{rt} + \sum \beta_j control_{it} + \mu_i + \lambda_{jt} + \delta_{rt} + \varepsilon_{ijrt} \quad (1)$$

where *energy* represents firm-level energy consumption (measured in standard coal equivalents), *DID* represents the NEDCC policy dummy variable, control represents the control variables. Model (1) also control firm fixed effects (μ_i), industry $\times$ year fixed effects (λ_{jt}), and city $\times$ year fixed effects (δ_{rt}). The multiple fixed effects structure eliminates confounding factors from time-invariant firm characteristics, temporal macroeconomic fluctuations, industry-specific technological changes, and city-level parallel policy interventions. ε_{ijrt} represents stochastic error term. The coefficient β_1 represents the average treatment effect, where a statistically significant negative value indicates successful energy reduction.

The dependent variable is constructed through comprehensive data extraction from Annual reports, CSR disclosures, and investor relations materials. Energy consumption data are standardized using official conversion factors (see Table 1 for detailed methodology), ensuring cross-fuel comparability. Notably, a potential concern regarding the firm-level energy consumption data is the heterogeneity in corporate disclosure practices, which might introduce measurement error. We address this in several ways. First, our data collection strictly relied on quantitative disclosures from official reports, and all energy types were standardized using official conversion coefficients. More importantly, any remaining measurement error is likely to be time-invariant firm-specific characteristics (e.g., a firm's consistent under-reporting of minor energy sources). Such non-differential measurement error is largely absorbed by the city-fixed effects in our panel model. Since our identification strategy relies on comparing within-city changes over time, and there is no plausible reason that the NEDC policy systematically alters the granularity of energy reporting, the error is unlikely to be correlated with the treatment timing. Therefore, it does not confound the estimated policy effect, which is identified from temporal changes relative to the policy implementation.

Table 1. Energy consumption structure.

Energy Consumption Type	Water	Electricity	Coal	Natural Gas	Gasoline	Diesel	Central Heating	Total Energy Consumption
Unit	10,000 tons	10,000 kWh	10,000 tons	10,000 m ³	10,000 tons	10,000 tons	10,000 GJ	10,000 tons of standard coal equivalent (SCE)
Conversion Factor	0.0002429	1.229	0.7143	13.3	1.4714	1.4571	0.03412	/

Note: Conversion factors are sourced from the official website of the National Energy Administration of China, data sources include annual reports of listed companies, corporate social responsibility reports of listed companies, and information from the official websites of listed companies.

The core explanatory variable is a dummy variable indicating the NEDCC policy. Following the DID estimation framework, this variable takes the value of 1 if a firm is in a pilot city and the year is the policy implementation year or later, and 0 otherwise. China's NEDCC pilot program was launched in 2014; thus, firms in the pilot cities from 2014 onward are assigned a value of 1, while all others are coded as 0.

To mitigate potential endogeneity arising from omitted variables, model (1) controls for a comprehensive set of firm-level characteristics that may influence corporate energy consumption, including company size, financial condition, growth potential, corporate governance, and market performance [2,3,7,29,30,45]. Company size includes total assets (measuring overall scale), total revenue (reflecting business scale), total market value (capturing market valuation). Financial condition includes asset-liability ratio (measuring financial structure), current ratio (measuring short-term solvency), net profit margin (reflecting profitability), return on total assets (measuring asset utilization efficiency), and return on equity (reflecting shareholder equity returns). Growth potential includes revenue growth rate (capturing sales expansion), net Profit growth rate (capturing earnings growth), and total asset growth rate (capturing asset expansion speed). Corporate governance includes management ownership (measured by the shareholding ratios of the board chairman and general manager, reflecting alignment between management and shareholder interests) and equity concentration (sum of the top five shareholders' stakes, indicating equity distribution). Market performance includes price-to-earnings ratio (capturing market expectations of future profitability) and price-to-book ratio (capturing market valuation of net assets). Additionally, Model (1) controls for other factors, including firm listing age (measuring years since listing), R&D investment ratio (measuring innovation capability), and capital expenditure (measuring investment activities). All data are sourced from listed firms' annual reports and official websites.

Consistent with the theoretical framework, the impact of the NEDCC policy on corporate energy consumption may operate through two key channels: green innovation and digital transformation. This study measures green innovation using two variables: green technological innovation and green M&As. Green technological innovation is measured by the number of green patent applications, including both green invention patents and green utility model patents. A higher count indicates stronger corporate commitment to green technology development [46]. Patent classification codes for all A-share listed firms were obtained from the China Research Data Service Platform (CNRDS) and matched with the WIPO's 2010 "International Patent Classification Green List". The total count of green patent applications was derived by summing green invention and utility model patents. Green M&As is identified through textual analysis of corporate M&As announcements, assessing the background, objectives, and business scope of both acquiring and target firms to determine whether the transaction qualifies as a green M&A. Green M&As is measured as a dummy variable (1 if the M&As is green, 0 otherwise), with the total count of green M&As per firm also recorded.

Our approach does not rely on a pre-defined keyword list. Instead, we implement a comprehensive, manual content analysis of each M&A announcement based on a struc-

tured framework. This framework assesses the transaction across three complementary dimensions to triangulate its “green” intent. First, we analyze the narrative provided by the acquirer regarding why the transaction was being undertaken. We look for explicit statements linking the M&A to the firm’s environmental strategy, such as “to acquire advanced energy-saving technology,” “to achieve the company’s carbon reduction goals,” or “to transition into the renewable energy sector.” Second, we meticulously examine the primary business activities and products/services of the target company. A transaction is considered “green” if the target firm was primarily engaged in industries officially classified as environmentally friendly or low carbon (e.g., solar panel manufacturing, waste management, energy efficiency services), regardless of the acquirer’s stated purpose. This objective criterion serves as a strong validation. Third, we evaluate the likely post-merger impact on the acquirer’s business model. If the acquisition is clearly aimed at transforming the acquirer’s core operations towards less polluting or more energy-efficient activities, it is classified as green.

Digital transformation is constructed via textual analysis of annual reports, where keyword frequencies related to digital transformation (e.g., “big data,” “AI,” “blockchain”) were aggregated into a composite index [47]. Due to the right-skewed distribution of the raw data, a logarithmic transformation was applied to derive the final metric.

Due to the persistent disruptions to corporate production activities caused by COVID-19 since 2020, energy consumption has decreased significantly compared to normal conditions. To ensure the validity of the DID estimation, this paper excludes relevant data from the period 2020 to 2022. The final sample comprises 1363 A-share listed companies on the Shanghai and Shenzhen stock exchanges from 2007 to 2023, excluding the years 2020 to 2022, covering 235 cities in China. Among these, 45 cities were selected for the NEDCC pilot program. Firms located in these pilot cities constitute the treatment group, while those in non-pilot cities form the control group. To mitigate potential collinearity between listing age and fixed effects, a logarithmic transformation is applied to listing age. Similar transformations are performed on control variables such as energy consumption and green patents. Descriptive statistics for the main variables are presented in Table 2.

Table 2. Descriptive statistics of all variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
Total energy consumption	19,082	1134.591	330.804	554.625	1810.088
DID	19,082	0.0863	0.2808	0	1
Listing age	19,082	14.5899	5.3302	1	29
Capital expenditure	19,046	8.25×10^8	4.59×10^9	−9049	1.58×10^{11}
R&D investment ratio	19,082	1.4306	5.1030	0	342.34
Total market value	19,035	1.38×10^7	5.40×10^7	201,092	2.04×10^9
Total assets	19,063	22.2631	1.5799	10.8422	31.0359
Total revenue	18,829	21.4858	1.7373	9.0442	28.7183
Asset-liability ratio	19,063	0.6164	2.3344	−0.1947	142.7178
Current ratio	18,851	1.7435	2.8436	−5.1316	204.7421
Net profit margin	19,056	10.2956	922.0751	−2637.694	108,836.4
Return on total assets (ROA)	19,063	1.3929	176.8057	−51.9468	23,509.77
Return on equity (ROE)	18,828	0.0327	1.5152	−174.8947	33.8313
Revenue growth rate	19,044	3.2065	71.2471	−2266.483	4882.519
Net profit growth rate	17,735	−0.1076	402.6065	−12,569.86	45,174.36
Total asset growth rate	19,064	0.1632	1.4074	−1	107.1283
Chairman’s shareholding ratio	19,082	0.9133	4.3293	0	49.66
General manager’s shareholding ratio	19,082	0.4952	3.0690	0	49.66
Equity concentration	19,064	49.1522	15.6759	0.8109	97.4129
Price-to-earnings ratio (P/E ratio)	18,306	135.6182	482.302	0.3018	20,135.27
Price-to-book ratio (P/B ratio)	18,691	6.4029	41.0821	0.1214	2788.704
Green patent	19,082	2.0059	23.0149	0	1004
Green M&As	19,082	0.5356	1.5624	0	48
Digital transformation	19,082	0.7729	1.1424	0	6.1485

4. Results and Discussion

4.1. Benchmark Results

Table 3 presents the regression results. Each column progressively incorporates control variables, including other factors, financial conditions, growth potential, corporate governance, market performance, and company size. All specifications employ city-level clustered standard errors. The DID coefficients remain consistently negative and statistically significant across all model specifications, indicating that the NEDCC program effectively reduced energy consumption among listed firms in treatment cities. The estimated coefficients range from -0.011 to -0.013 , demonstrating robust policy effects after controlling for various firm characteristics. The full model suggests that the policy implementation leads to approximately a 1.3% reduction in logged energy consumption. Based on the average energy consumption level of 8.7 million tons of SCE for firms in the treatment group during the pre-policy period, a reduction of 1.3% equates to an average decrease of approximately 113,100 tons of SCE per firm per year. While direct comparisons with existing findings are limited due to measurement differences, these results align with broader evidence on green development policies. For instance, Liu et al. found the NEDCC policy reduced corporate energy intensity [29]; He et al. documented improved total-factor energy efficiency among energy-intensive firms [30]. Table 3 provides strong empirical support for Hypothesis 1.

Table 3. Effects of NEDCC on corporate energy consumption.

	Independent Variable: Corporate Energy Consumption					
DID	-0.012^{***} (-6.99)	-0.011^{***} (-6.26)	-0.011^{***} (-5.63)	-0.011^{***} (-5.50)	-0.012^{***} (-5.84)	-0.013^{***} (-5.84)
Listing age	0.081^{***} (735.27)	0.081^{***} (699.63)	0.081^{***} (550.41)	0.081^{***} (537.06)	0.081^{***} (490.99)	0.081^{***} (334.60)
Capital expenditure	0.001^{**} (2.87)	0.000 (1.00)	-0.000 (-0.46)	0.001 (1.31)	0.001 (1.53)	-0.000 (-0.41)
R&D investment ratio	-0.000 (-0.47)	0.000 (0.03)	0.000 (1.45)	0.000 (0.98)	0.000 (1.40)	0.000 (1.46)
Financial condition	NO	YES	YES	YES	YES	YES
Growth potential	NO	NO	YES	YES	YES	YES
Corporate governance	NO	NO	NO	YES	YES	YES
Market performance	NO	NO	NO	NO	YES	YES
Company size	NO	NO	NO	NO	NO	YES
Constant	5.782^{***} (740.13)	5.795^{***} (697.33)	5.812^{***} (620.57)	5.831^{***} (613.96)	5.809^{***} (495.27)	5.692^{***} (191.43)
Individual fixed effects	YES	YES	YES	YES	YES	YES
Industry $\times$ time fixed effects	YES	YES	YES	YES	YES	YES
City $\times$ time fixed effects	YES	YES	YES	YES	YES	YES
Number of obs	18,969	18,548	17,377	17,377	17,113	17,099
R2	0.963	0.962	0.961	0.961	0.961	0.961

Note: *t* statistics in parentheses; ** $p < 0.01$, *** $p < 0.001$.

Table 4 presents the differential impacts of NEDCC policies across various energy types. The results demonstrate that the NEDCC policy has led to significant reductions in fossil fuel consumption including coal, natural gas, and diesel. The policy significantly reduced coal usage, likely through the direct substitution effects toward renewables (wind/solar) and technology-upgrading incentives (e.g., subsidies for efficient boilers). The natural gas findings present an interesting nuance: despite its cleaner profile relative to coal, decreased consumption indicates the policy may be accelerating the adoption of non-fossil alternatives beyond simple fuel switching. The reduction in diesel consumption is likely attributable to its primary use in transportation and heavy machinery. The NEDCC policy plausibly encouraged a shift toward electric or clean-energy vehicles in these sectors. Additionally,

the policy may have indirectly reduced diesel demand by promoting higher fuel efficiency standards and alternative energy sources.

Table 4. Effects of NEDCC on different types of energy consumption.

	Water	Electricity	Coal	Natural Gas	Gasoline	Diesel	Central Heating
DID	−0.001	−0.023	−0.013 ***	−0.012 ***	−0.007	−0.017 ***	−0.001
Control variable	(−0.85) YES	(−1.77) YES	(−5.93) YES	(−5.14) YES	(−1.34) YES	(−4.69) YES	(−0.12) YES
Constant	−0.121 *** (−7.49)	−0.696 *** (−4.22)	3.076 *** (104.93)	2.925 *** (91.67)	2.211 *** (42.73)	2.435 *** (59.91)	1.638 *** (18.37)
Individual fixed effects	YES	YES	YES	YES	YES	YES	YES
Industry × time fixed effects	YES	YES	YES	YES	YES	YES	YES
City × time fixed effects	YES	YES	YES	YES	YES	YES	YES
Number of obs	17,099	17,099	17,099	17,099	17,099	17,099	17,099
R ²	0.964	0.964	0.960	0.953	0.853	0.914	0.684

Note: *t* statistics in parentheses; *** *p* < 0.001.

Table 4 further demonstrates that while the NEDCC policy showed some reduction effects on water, electricity, gasoline and central heating consumption, these impacts were not statistically significant. The limited effect on water usage likely reflects the policy's weaker direct relevance to water conservation measures. Although the new energy policy promotes cleaner electricity generation (such as wind and solar power)—representing a structural shift in power composition—the potential reduction in total electricity consumption appears offset by countervailing factors including economic growth and enterprise expansion. For gasoline, primarily used in light-duty vehicles, the policy's influence remained minimal due to its narrower focus on heavy transport sectors. In summary, the results clearly indicate that the new energy demonstration city policy achieved statistically significant reductions in coal, natural gas and diesel consumption. These findings provide empirical evidence that the policy has produced initial success in facilitating corporate transition toward cleaner energy sources while improving energy efficiency.

4.2. Robustness Tests

4.2.1. Parallel Trend Hypothesis Test

The DID estimator requires the parallel trends assumption to hold between treatment and control groups to ensure unbiased estimation. This study employs an event study approach to test the validity of this assumption. The event study methodology, a widely adopted test for parallel trends, examines whether pre-treatment trends are similar across groups by incorporating time dummy variables. The parallel trends assumption is considered satisfied if the estimated coefficients for pre-treatment periods are statistically insignificant while post-treatment coefficients show significance. The verification model is specified as follows:

$$energy_{it} = \beta_0 + \sum_{k \neq -1}^n \beta_k DID_{rt}^k + \sum \gamma_j control_{it} + \mu_i + \lambda_{jt} + \delta_{rt} + \varepsilon_{ijrt} \quad (2)$$

DID_{rt}^k represents event time dummy variable, indicating whether observation *i* at time *t* corresponds to event window *k* (where *k* denotes relative time periods before/after policy implementation). The coefficient β captures the treatment effect at event time *k*. Following convention, the baseline period is set to *k* = −1 (one period prior to policy intervention) and excluded to avoid multicollinearity. The test results, presented in Table 5, demonstrate

that NEDCC shows no statistically significant effect on corporate energy consumption (confidence intervals include zero) during pre-treatment periods while exerting significantly negative impacts (confidence intervals exclude zero) during post-treatment periods. This pattern satisfies the parallel trends assumption required for DID estimation. Table 5 also presents the dynamic path of the policy effect. It can be observed that the negative effect emerges in the first year following the policy implementation (post_1) and demonstrates a gradually strengthening trend in the subsequent years. This indicates that the energy-saving effect of the NEDC policy is not instantaneous; rather, the benefits accumulate and amplify as firms progressively engage in green innovation, strategic adjustments, and digital transformation, underscoring the policy's long-term importance.

Table 5. Parallel trend test.

Period	Coef.	95% Conf. Interval	
pre_7	−0.005	−0.014	0.004
pre_6	−0.005	−0.013	0.004
pre_5	0.000	−0.008	0.009
pre_4	−0.005	−0.013	0.004
pre_3	−0.003	−0.012	0.005
pre_2	−0.007	−0.015	0.002
0	0.005	−0.004	0.013
post_1	−0.013	−0.021	−0.004
post_2	−0.014	−0.022	−0.005
post_3	−0.011	−0.020	−0.002
post_4	−0.012	−0.021	−0.003
post_5	−0.013	−0.022	−0.004
post_6	−0.015	−0.024	−0.006

Note: The event window—7 years before and 6 years after the policy implementation in 2014—was determined entirely by data availability, rather than arbitrary or ad hoc selection. Specifically: The starting year of our panel data is 2007, which naturally defines the maximum possible pre-treatment period (2007–2013 = 7 years). The end year of our sample is 2023, which allows for a maximum of 6 post-treatment years (2015–2019, excluding the pandemic years 2020–2022, plus 2023). Thus, the pre-7/post-6 window represents the full span of available non-pandemic data surrounding the policy shock. We did not artificially truncate the window (e.g., to pre-5/post-4) because doing so would have omitted valuable pre- and post-treatment information without justification. Similarly, extending the window beyond pre-7 or post-6 was not feasible due to data constraints.

4.2.2. Counterfactual Test

To further validate the causal interpretation, we conduct a counterfactual test by artificially advancing the NEDCC policy implementation timeline. This approach examines whether pre-existing trends or unobserved confounding factors might drive the observed reductions in corporate energy consumption. Specifically, we assume fictitious policy implementation dates that precede the actual intervention by 1 year and 2 years. If the DID estimates remain statistically significant under these false treatment timings, it would suggest potential confounding factors. Otherwise, insignificant coefficients would support the causal attribution to the actual NEDCC policy. As shown in Columns 1–2 of Table 6, the DID coefficients under counterfactual treatments are positive but statistically insignificant. These results rule out anticipatory effects or pre-trend biases and confirm that the energy consumption reductions are uniquely attributable to the NEDCC policy implementation.

Furthermore, we conduct an additional placebo test through random reassignment of treatment and control groups. The procedure is implemented as follows. For each year from 2014 onward, we randomly select cities as placebo treatment groups, matching the exact number of actual NEDCC pilot cities in that year. The remaining cities serve as placebo control groups. This process is repeated for 1000 iterations. The kernel density plot (Figure 2) displays the distribution of the 1000 estimated coefficients. The coefficients are normally distributed around zero, with almost all of the estimates falling within the [−0.005,

0.005] range. This distribution is markedly distinct from our baseline estimate of -0.013 . Therefore, the observed energy reduction is not driven by city-specific characteristics, and the treatment effect is uniquely associated with actual NEDCC implementation. This further validates the causal interpretation of NEDCC's energy conservation effects.

Table 6. Robustness test.

	Advance_1	Advance_2	Winsorization	Controlling Concurrent Environmental Policies	PSM-DID
Independent Variable: Corporate Energy Consumption					
DID	0.044 (1.36)	0.047 (1.61)	-0.014^{***} (-5.81)	-0.010^{***} (-5.79)	-0.008^{***} (-3.59)
Control variable	YES	YES	YES	YES	YES
LCCP				-0.008^{***} (-3.67)	
ETS				-0.011^{***} (-3.26)	
Constant	5.684^{***} (203.66)	5.671^{***} (205.32)	5.715^{***} (195.67)	5.203^{***} (202.31)	5.779^{***} (184.15)
Individual fixed effects	YES	YES	YES	YES	YES
Industry $\times$ time fixed effects	YES	YES	YES	YES	YES
City $\times$ time fixed effects	YES	YES	YES	YES	YES
Number of obs	17,099	17,099	17,099	17,099	15,415
R ²	0.963	0.963	0.960	0.928	0.957

Note: *t* statistics in parentheses; *** $p < 0.001$.

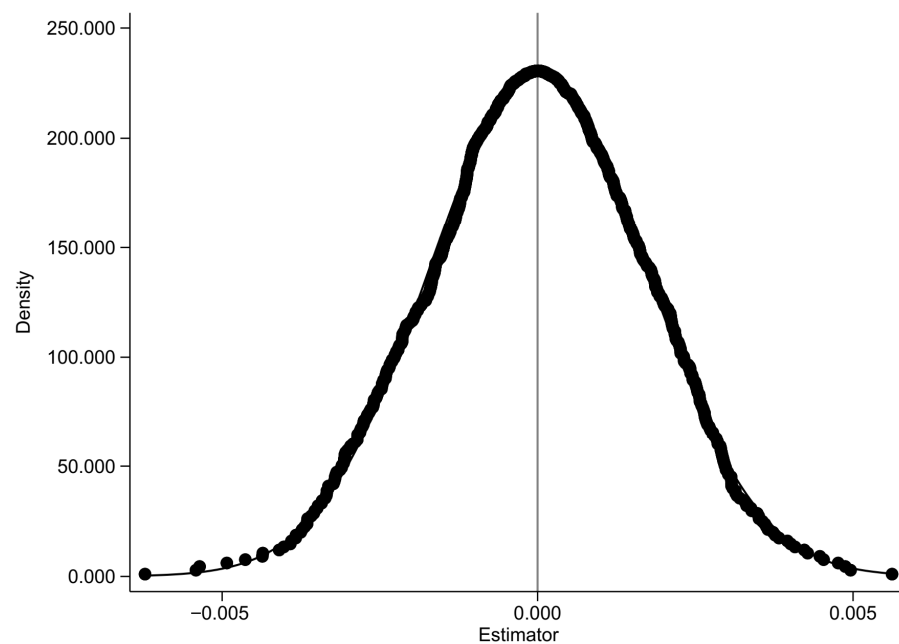


Figure 2. Placebo test.

4.2.3. Winsorization of Extreme Values

Although abnormal periods such as the pandemic have been excluded during sample selection, we further apply winsorization to all continuous variables to ensure that the estimation results are not driven by extreme observations. Specifically, values below the 1st percentile and above the 99th percentile for each continuous variable are replaced with the values at the 1st and 99th percentiles, respectively. This approach effectively mitigates the excessive influence of outliers on the estimated coefficients and is a commonly used robustness method in econometrics. As shown in column 3 in Table 6, when re-estimating

the model using the winsorized sample, the estimated coefficient of the NEDC policy dummy and its significance level are highly consistent with the baseline regression results reported in Table 3. This provides strong evidence that our core conclusion—that the construction of new energy demonstration cities significantly reduces corporate energy consumption—is not driven by individual extreme values and that the results are robust.

4.2.4. Controlling Concurrent Environmental Policies

Although pre-trends were ruled out through event study test and counterfactual test, we augmented Model (1) by including dummy variables for whether a city was subject to other major environmental policies, specifically, the low-carbon city pilot (LCCP) and the carbon emissions trading scheme pilot (ETS), to mitigate potential confounding effects from these concurrent initiatives. As shown in column (6) of Table 5, after controlling these two policies, the estimated coefficient for the NEDC policy remains virtually unchanged at -0.012 and continues to be highly significant at the 1% level, indicating that the baseline finding is robust.

4.2.5. PSM-DID Estimation

The selection of NEDCC typically considers factors including urban energy structure, environmental pressures, economic development levels, and renewable energy industry foundations. This selection process may introduce bias, as large listed firms in pilot cities—with superior resource acquisition and technological capabilities—often respond more effectively to policy incentives and benefit disproportionately from support measures like subsidies and tax incentives. To mitigate this potential selection bias, we implement propensity score matching (PSM) to construct a robust control sample. The methodology proceeds as follows.

Treatment variable: City's NEDCC pilot status (binary).

Covariates: All control variables from Model (1) [48].

Matching algorithm: 1:1 nearest-neighbor matching with logit model.

The balance test results are presented in Table 7. Prior to matching, significant differences existed between the treatment and control groups for nearly all covariates. After matching, none of the covariate differences remained statistically significant, indicating substantially improved matching quality. Re-estimating Model (1) using the matched sample shows that NEDCC continues to exert a statistically significant negative effect on corporate energy consumption (Column 5, Table 6), confirming the robustness of the baseline regression results.

4.3. Heterogeneity Test

Corporate ownership structure typically influences operational and managerial decisions, which may consequently affect energy consumption patterns. To examine potential heterogeneous effects of the NEDCC policy, we disaggregate the sample into SOEs and non-SOEs. Furthermore, SOEs are subdivided into locally controlled SOEs and centrally administered SOEs. This stratification allows us to assess whether the policy differentially impacts energy consumption across distinct ownership types. The group regression results are reported in Table 8. After controlling for three fixed effects, the DID coefficients are significantly negative for local SOEs (Column 1), Non-SOEs (Column 3), Non-state-controlled firms (Column 4), and State-controlled firms (Column 5). In contrast, the coefficient is statistically insignificant for central SOEs (Column 2). Therefore, the NEDCC policy significantly reduces energy consumption in local SOEs. The significant reduction likely stems from their close ties with local governments, enabling swift policy compliance. Local authorities may further incentivize energy conservation through fiscal subsidies or tax incentives.

Table 7. Balance test for covariates.

Variable	Unmatched Mean			%Bias	%Reduction Bias	t-Test	
	Matched	Treated	Control			t	p > t
Total market value	U	15.971	15.588	38.8	98.3	12.97	0.000
	M	15.973	15.966	0.7		0.17	0.865
Total assets	U	22.764	22.301	33.1	96.2	11.50	0.000
	M	22.768	22.786	−1.3		−0.31	0.754
Total revenue	U	22.004	21.632	23.4	92.3	8.10	0.000
	M	22.012	21.984	1.8		0.44	0.657
Asset-liability ratio	U	0.5650	0.5133	4.1	99.0	3.24	0.001
	M	0.5166	0.5160	0.0		0.06	0.949
Current ratio	U	1.7905	1.7449	1.6	−32.1	0.58	0.559
	M	1.7943	1.7339	2.2		0.64	0.522
Net profit margin	U	0.0290	−0.1048	0.9	92.4	0.22	0.826
	M	0.0621	0.0519	0.1		0.20	0.838
ROA	U	−0.0064	0.0352	−4.4	98.6	−3.54	0.000
	M	0.0305	0.0299	0.1		0.22	0.823
ROE	U	0.0560	0.0656	−1.8	−122.1	−0.49	0.621
	M	0.0569	0.0356	4.0		1.22	0.222
Revenue growth rate	U	1.1088	2.1517	−2.6	−32.2	−0.67	0.502
	M	1.1119	2.4901	−3.4		−1.13	0.257
Net profit growth rate	U	1.6976	−0.4987	1.8	58.3	0.50	0.614
	M	2.3276	3.2438	−0.8		−0.32	0.751
Total asset growth rate	U	0.2245	0.1601	4.9	−25.2	2.19	0.029
	M	0.2257	0.1452	6.1		1.70	0.089
Chairman’s shareholding ratio	U	1.2319	0.9350	6.4	91.1	2.33	0.020
	M	1.2347	1.2084	0.6		0.13	0.893
General Manager’s shareholding ratio	U	0.7461	0.4955	7.2	52.1	2.77	0.006
	M	0.7478	0.6277	3.4		0.81	0.416
Equity concentration	U	50.243	49.594	4.2	5.4	1.44	0.150
	M	50.294	49.68	4.0		0.99	0.323
P/E ratio	U	3.8646	3.8792	−1.2	−167.3	−0.44	0.662
	M	3.8606	3.8996	−3.3		−0.79	0.429
P/B ratio	U	1.3623	1.3941	−4.8	78.3	−1.73	0.083
	M	1.3608	1.3676	−1.0		−0.25	0.799
Listing age	U	17.97	14.127	79.7	99.8	25.83	0.000
	M	17.971	17.964	0.1		0.04	0.967
Capital expenditure	U	18.7	18.526	8.1	97.3	2.81	0.005
	M	18.703	18.707	−0.2		−0.05	0.957
R&D investment ratio	U	2.2411	1.2536	23.5	98.6	11.01	0.000
	M	2.0745	2.0888	−0.3		−0.10	0.924

Regarding non-SOEs and non-state-controlled enterprises, these entities demonstrate market agility and innovative capacity, allowing rapid operational adjustments (e.g., adopting clean technologies or optimizing production processes) to align with policy requirements. This aligns with Biagini and Miller who documented proactive climate adaptation strategies among private firms in developing economies [49]. While the state-controlled group shows significant reductions—potentially due to their resource advantages and policy responsiveness—the null effect for central SOEs suggests structural constraints. These enterprises dominate strategic sectors (e.g., energy, utilities) with inherent consumption rigidities and cross-regional operations, limiting local policy leverage.

The NEDCC policy aims to achieve comprehensive energy conservation and emissions reduction at the city level, with a particular focus on decarbonizing industrial structures and transitioning to renewable energy systems. Given this orientation, the policy may exert stronger effects in high-carbon industries. To examine potential sectoral variations in the policy’s impact on corporate energy consumption, we stratify the sample according to the China Securities Regulatory Commission’s industry classification standards. Col-

umn 2 in Table 9 reveals that the NEDCC policy significantly reduces energy consumption in manufacturing firms. As the cornerstone of China’s energy conservation efforts, the manufacturing sector demonstrates several responsive mechanisms, include technological upgrading by Increasing R&D investment in renewable energy technologies and replacing conventional fuel-based equipment with efficient electric alternatives, structural optimization by Shifting toward low-energy-intensity, high-value-added products and phasing out energy-intensive production processes, and scale effects (e.g., larger manufacturers leverage policy support (e.g., subsidies) to accelerate green transitions and enhance energy efficiency through economies of scale).

Table 8. Heterogeneity test: Different types of ownership.

	Local SOEs	Central SOEs	Non-SOEs	Non-State-Controlled Enterprises	State-Controlled Enterprises
Independent Variable: Corporate Energy Consumption					
DID	−0.013 *** (−4.66)	−0.015 (−1.36)	−0.010 * (−2.44)	−0.011 ** (−2.84)	−0.014 *** (−5.35)
Control variable	YES	YES	YES	YES	YES
Constant	5.561 *** (102.32)	5.859 *** (28.57)	5.871 *** (138.66)	5.877 *** (138.24)	5.610 *** (114.37)
Individual fixed effects	YES	YES	YES	YES	YES
Industry × time fixed effects	YES	YES	YES	YES	YES
City × time fixed effects	YES	YES	YES	YES	YES
Number of obs	9354	1413	6333	6273	10,826
R ²	0.960	0.953	0.958	0.958	0.961

Note: *t* statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 9. Heterogeneity test: Different industries.

	A	B	C	D	E	F	G	H	I	J	K	L	M
Independent Variable: Corporate Energy Consumption													
DID	0.001 (0.09)	−0.011 *** (−3.83)	−0.022 * (−2.27)	−0.015 (−0.97)	−0.027 ** (−2.90)	0.004 (0.42)	0.008 (0.58)	−0.036 * (−2.52)	−0.002 (−0.21)	−0.074 * (−2.60)	0.032 * (2.45)	0.009 (0.34)	−0.041 (−1.48)
Control variable	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Constant	5.337 *** (15.48)	5.650 *** (127.06)	6.113 *** (29.09)	5.240 *** (19.34)	5.802 *** (33.94)	5.621 *** (30.57)	6.301 *** (14.07)	5.887 *** (21.47)	5.986 *** (35.97)	7.532 *** (16.29)	7.068 *** (10.92)	6.025 *** (18.42)	5.455 *** (20.76)
Individual fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry × time fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
City × time fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Number of obs	531	9744	928	416	1382	786	68	487	1398	203	172	159	424
R ²	0.958	0.960	0.963	0.961	0.953	0.961	0.981	0.953	0.952	0.939	0.908	0.946	0.938

Note: *t* statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The China Securities Regulatory Commission categorizes listed companies into 19 industries. However, due to insufficient sample size in certain classifications that do not meet the regression requirements, this study obtains estimation results for 13 industries. These 13 industries are sequentially coded as follows. A: Mining Industry; B: Manufacturing Industry; C: Electricity, Heat, Gas, and Water Production and Supply Industry; D: Construction Industry; E: Wholesale and Retail Trade; F: Transportation, Storage, and Postal Services; G: Accommodation and Catering Services; H: Information Transmission, Software, and Information Technology Services; I: Real Estate Industry; J: Leasing and Business Services; K: Water Conservancy, Environment, and Public Facilities Management; L: Culture, Sports, and Entertainment Industry; M: Comprehensive Industry.

The electricity, heat, gas, and water supply sector—other core energy-consuming industries—also exhibits significant energy reduction under the NEDCC policy (Column 3).

This outcome stems from two primary reasons. One is regulatory mandates which lead to direct requirements to increase clean energy penetration (e.g., grid integration of wind/solar power) and structural shifts toward renewable generation, reducing fossil fuel dependence. The other is technology-driven efficiency gains including adoption of combined heat and power systems, implementation of smart grid technologies to minimize transmission losses, and cost reductions through policy subsidies for renewable projects. Interestingly, Table 9 reveals that the NEDCC policy significantly reduces energy consumption in the wholesale and retail sector—a finding that merits careful interpretation given the sector’s non-energy-intensive profile. Three possible mechanisms explain this result under the NEDCC policy. The first is logistics optimization by adopting new energy vehicles for goods transportation and improving route efficiency in distribution networks. The second is store operations management via installing energy-efficient lighting systems and upgrading to HVAC systems in retail spaces. The third is supply chain integration, such as collaborative inventory management with suppliers to reduce excess stock and streamlined warehousing and distribution cycles.

The results further demonstrate significant energy consumption reductions in two tertiary sectors: information technology services and leasing and business services. The potential mechanisms include energy optimization in data centers through efficient servers and cooling systems, accelerated digital transformation reducing physical infrastructure needs, adoption of remote work models decreasing office energy use and commuting, improved energy management in commercial spaces, and deployment of energy-efficient office technologies. Conversely, the policy appears to increase energy consumption in the water conservancy, environment, and public utilities sector. This observed increase in energy consumption may be attributed to the substantial infrastructure requirements associated with new energy demonstration projects, including the construction of renewable energy power stations and transmission lines. Enterprises in the water conservancy, environment, and public utilities sector typically undertake these infrastructure development and maintenance activities, which inherently lead to higher energy expenditures. Furthermore, the implementation of new energy projects necessitates concomitant environmental remediation and ecological protection measures—such as land reclamation and vegetation restoration—that also contribute to additional energy consumption. As also evidenced in Table 9, the NEDCC policy demonstrates statistically insignificant effects on several sectors: mining, construction, accommodation and food services, culture, sports, and entertainment, and comprehensive industries.

These differential impacts across sectors collectively provide empirical validation for Hypothesis 2.

4.4. Mechanism Path Test

This study further employs stepwise regression analysis to verify whether NEDCC reduces corporate energy consumption through three pathways—technological innovation, green M&As, and digital transformation (Table 10). The results show that the DID estimate for green technological innovation is significantly positive (Column 1), indicating NEDCC significantly promotes green innovation, while green innovation itself is significantly negatively associated with energy consumption, demonstrating its role in reducing energy use. These findings confirm Hypothesis 3 that NEDCC policies significantly lowers corporate energy consumption by fostering green technological innovation, consistent with He et al. who identified technological innovation as a key channel through which NEDCC enhances total-factor energy efficiency [30] and aligned with Chai et al. who found NEDCC improves urban carbon emission efficiency through green innovation [12]. Green technological progress emerges as a critical factor in enhancing corporate energy efficiency, as the

new energy city initiative provides policy support, funding, and an innovation-conducive environment that incentivizes firms to increase R&D investment in green technologies. Such innovation facilitates the adoption of more efficient energy utilization technologies and equipment, including energy-saving production machinery and advanced energy management systems, which directly reduce energy consumption in production processes.

Table 10. Influence mechanism.

	Independent Variable					
	Green Patent	Corporate Energy Consumption	Green M&As	Corporate Energy Consumption	Digital Transformation	Corporate Energy Consumption
DID	0.018 *** (4.50)	−0.013 *** (−5.84)	0.019 ** (2.92)	−0.012 *** (−5.80)	0.043 ** (2.75)	−0.012 *** (−5.62)
Green patent		−0.001 ** (3.33)				
Green M&As				−0.005 *** (−3.84)		
Digital Transformation						−0.007 *** (−7.55)
Control variable	YES	YES	YES	YES	YES	YES
Constant	−0.806 ** (−3.12)	5.693 *** (191.31)	−0.592 ** (−2.88)	5.689 *** (192.33)	−6.502 *** (−12.16)	5.646 *** (187.87)
Individual fixed effects	YES	YES	YES	YES	YES	YES
Industry × time fixed effects	YES	YES	YES	YES	YES	YES
City × time fixed effects	YES	YES	YES	YES	YES	YES
Number of obs	17,099	17,099	17,099	17,099	17,099	17,099
R ²	0.062	0.961	0.0133	0.961	0.376	0.961

Note: *t* statistics in parentheses; ** $p < 0.01$, *** $p < 0.001$.

The results in Column 3 demonstrate that NEDCC has a significantly positive effect on green M&As, indicating this policy stimulates corporate green M&As activities, while Column 4 shows green M&As exerts a significantly negative impact on corporate energy consumption, thereby validating Hypothesis 4. The establishment of new energy cities sends a strong market signal about the necessity for enterprises to actively address environmental challenges and pursue sustainable development, which enhances corporate market reputation and boosts investor confidence in green investments, consequently attracting more resources to support corporate green transformation. To maintain favorable market perceptions, firms increase green M&As activities and strengthen energy consumption management by adopting effective measures to reduce energy use in line with market expectations for their green development. Green M&As enable acquiring firms to obtain targets' green technologies, management expertise, and resources, achieving optimal resource allocation and synergistic effects; through integrating complementary strengths, firms can utilize energy more efficiently and ultimately reduce energy consumption, with the combined entity's enhanced capabilities facilitating better energy management practices and more sustainable operations across the merged organization.

The results demonstrate that NEDCC has a significantly positive effect on digital transformation (Column 5), indicating the policy effectively promotes corporate digitalization, while digital transformation itself shows a significantly negative impact on energy consumption (Column 6), thereby confirming Hypothesis 5. The policy drives corporate digitalization through multiple channels including policy incentives, market demand, technological convergence, data-driven decision making, and strategic realignment, with digital transformation enabling enterprises to establish advanced information systems for more accurate monitoring and management of energy usage, allowing timely identification and correction of energy waste. Furthermore, digital optimization of production processes through automated equipment and intelligent control systems enhances production efficiency while reducing energy waste, and the development of new digital-based products

and services facilitates business model innovation that typically involves improved energy utilization methods, collectively contributing to significant energy conservation. These findings comprehensively validate the digital pathway through which NEDCC achieves its energy-saving effects, demonstrating how policy-induced digital transformation can systematically enhance energy efficiency across corporate operations through technological, managerial, and strategic innovations.

To ensure the robustness of our mediation analysis, we supplement the causal steps approach with the Bootstrap method (1000 repetitions). The results consistently showed significant indirect effects, as the 95% confidence intervals for all three mediators did not contain zero, reinforcing our conclusions (Given that the Bootstrap results strongly corroborate our initial findings—and considering the manuscript already contains 11 tables—we have chosen to summarize these confirmatory results rather than presenting detailed tables).

5. Further Analysis: External Factors

The impact of NEDCC on corporate energy consumption requires not only internal drivers, as demonstrated by the previously discussed channels, but also supportive external socioeconomic conditions. This study further examines how two critical external factors moderate NEDCC's effect on corporate energy consumption. The first factor is marketization level. Institutional theory suggests that regions with higher marketization possess more robust legal and credit systems that enhance policy compliance pressures [41], making firms more responsive to new energy city initiatives. In highly marketized NEDCC cities, sophisticated market mechanisms and flexible resource allocation systems enable more efficient energy utilization and reduce waste, while facilitating the phase-out of energy-intensive, low-efficiency industries and the development of low-energy, high-value-added emerging industries. Moreover, in these areas, government policies translate more effectively into corporate actions. Conversely, in less marketized regions, policy implementation relies heavily on administrative orders, often resulting in ceremonial adoption where firms make minimal, visible environmental investments to gain legitimacy without substantially altering energy consumption patterns [44].

Following the established methodology of Fan et al. [50], we construct an annual marketization index for each city from 2007 to 2023. This index measures regional marketization levels across five dimensions: government-market relations, non-state economic development, product market development, factor market development, and market intermediary organization development with legal environments. Dividing cities at the median marketization level, the regression analysis reveals significantly reduced corporate energy consumption under NEDCC in high-marketization regions (Columns 1–2, Table 11), but insignificant effects in low-marketization areas, confirming the theoretical expectations about the conditioning role of institutional environments in policy effectiveness.

The second critical external factor is the green financial environment. According to the principle of environmental finance externality internalization—which integrates Pigouvian tax theory and Coasian property rights theory—financial instruments transform the “social cost-private benefit” mismatch of environmental behaviors into quantifiable economic signals. When enterprises reduce energy consumption, conventional markets fail to automatically compensate for the resulting positive externalities. However, financial institutions can correct this through multiple mechanisms: price discovery and risk repricing instruments allow green finance to supplement firms' positive externalities via green credit, environmental rights mortgages, and ESG funds, while simultaneously constraining negative externalities through credit spreads for environmental violators and environmental pollution liability insurance. Specifically, green finance optimizes capital allocation by

directing funds toward energy-efficient projects and enterprises, thereby providing crucial financial support for corporate green technology innovation and ultimately reducing aggregate energy consumption.

Table 11. Further investigation: Different business environment.

	Classified by Marketization Level		Classified by Green Finance Level	
	Independent Variable: Corporate Energy Consumption			
	>Median	≤Median	>Median	≤Median
DID	−0.046 *** (−11.10)	−0.002 (−0.48)	−0.016 *** (−4.96)	−0.006 ** (−2.81)
Control variable	YES	YES	YES	YES
Constant	5.865 *** (118.02)	5.690 *** (102.05)	5.794 *** (144.26)	5.661 *** (111.78)
Individual fixed effects	YES	YES	YES	YES
Industry × time fixed effects	YES	YES	YES	YES
City × time fixed effects	YES	YES	YES	YES
Number of obs	8451	8648	8654	8445
R ²	0.929	0.948	0.953	0.955

Note: *t* statistics in parentheses; ** $p < 0.01$, *** $p < 0.001$.

This study adopts a distinct approach from Huang et al. [51] who equated green finance with green credit and differs from Hou and Shi [52] and Cheng, Kai et al. [53] who treated green finance as a quasi-natural experiment. Instead, we construct a comprehensive green finance index incorporating seven dimensions: green credit, green investment, green insurance, green bonds, green fiscal support, green funds, and environmental rights trading, measured, respectively, by the ratio of environmental project loans to total loans, environmental pollution control investment as a percentage of GDP, environmental liability insurance premium income as a proportion of total insurance income, green bond issuance volume relative to total bond issuance, environmental protection expenditure as a share of general fiscal budget expenditure, market capitalization of green funds as a percentage of total fund market capitalization, and trading volumes of carbon/energy/pollution rights in environmental markets. The seven dimensions are aggregated into a comprehensive green finance index using the entropy weight TOPSIS method. This objective weighting technique assigns higher weights to dimensions with greater variability across cities, ensuring that the composite index is derived scientifically from the data itself rather than from subjective judgments. Following the same methodology, we bifurcate the sample at the median green finance development level to examine differential policy effects. The results (Columns 3–4, Table 11) show that while NEDCC significantly reduces corporate energy consumption under both high and low green finance conditions, the effect is substantially stronger in regions with advanced green finance development, demonstrating that enhanced green financial ecosystems can amplify NEDCC’s energy conservation impact. So far, Hypothesis 6 is conclusively validated.

6. Conclusions and Implications

6.1. Conclusions

The establishment of new energy cities has emerged as a critical policy instrument for energy conservation and emissions reduction, aiming to reduce energy consumption across economic actors and increase renewable energy adoption through local government interventions and guidance. This study examines China’s NEDCC policy as a quasi-natural experiment, analyzing its impact on corporate energy consumption using panel data from A-share listed companies on the Shanghai and Shenzhen stock exchanges from 2007 to

2023. The results demonstrate that NEDCC significantly reduces corporate energy consumption, with particularly pronounced effects on coal, natural gas, and diesel usage. At the firm level, the policy significantly decreases energy consumption in local SOEs and non-SOEs—which typically exhibit greater market flexibility—while showing no significant effect on central SOEs. The policy’s energy reduction effects show no significant variation across different ownership structures but display notable industry heterogeneity, being particularly effective in manufacturing; electricity, heat, gas, and water production/supply; wholesale/retail; information technology services; leasing/business services; and water/environment/public utilities. The study verifies three primary mechanisms through which the policy achieves energy reduction: (1) the direct effect of technological innovation, (2) the acceleration effect of green M&As, and (3) the inclusive effect of digital transformation. The results further reveal heterogeneous policy effects across different external environments: the energy reduction effect is more pronounced in regions with higher marketization levels but insignificant in less marketized areas, while the policy significantly reduces energy consumption across all green finance development levels but demonstrates stronger effects in regions with more advanced green financial systems.

6.2. Theoretical Implications

The findings regarding the green technological innovation pathway resonate with the Porter Hypothesis, which posits that appropriate environmental regulations can stimulate firms to pursue green innovation, with the resulting value creation offsetting innovation costs through a compensation effect that generates positive environmental and social outcomes. The NEDCC policy provides empirical validation for this compensation effect of green innovation. The green M&As pathway aligns with institutional theory’s explanation of corporate strategy [41] while advancing understanding of both the resource-based view and synergy theory. The resource-based view emphasizes how firms acquire heterogeneous resources (such as through green M&As in this study) to gain competitive advantages [54], whereas synergy theory focuses on efficiency gains from post-merger resource integration [55]. The NEDCC policy creates an institutional, normative, and cultural environment that enables firms to rapidly obtain heterogeneous green technologies and resources through M&As, achieving energy efficiency and scale economies through resource integration that reduces energy waste and consumption, ultimately facilitating green transition. These findings not only enrich green M&As research but also provide new theoretical foundations for understanding how firms achieve green development through external resource integration. Furthermore, the digital transformation pathway confirms the reliability of the technology acceptance model in explaining corporate digital adoption under NEDCC policy. Digital transformation mitigates information asymmetries both internally and externally, optimizing resource allocation and enhancing production efficiency. The policy motivates comprehensive digital transformation, which enables precise energy monitoring and management through smart technologies, thereby reducing energy costs. This offers new theoretical perspectives on how digitalization drives the corporate green transition.

The findings further reveal differentiated response mechanisms based on corporate ownership structures. For local SOEs, local governments serve as both policy enforcers and benefit-sharing stakeholders, creating a political tournament-driven model of energy conservation where environmental performance becomes directly tied to official promotion incentives. Non-state-owned enterprises, characterized by well-defined property rights, exhibit market-sensitive energy reduction behaviors as environmental and energy costs become fully internalized into their operational decisions. Central SOEs demonstrate response lags due to inherent goal conflicts, as their evaluation systems continue to prioritize

economic indicators over environmental performance within the central government's assessment framework. The study also highlights how soft budget constraints—typically associated with SOEs—produce divergent energy conservation patterns under the new energy policy. For local SOEs, environmental performance metrics directly linked to political advancement create binding policy constraints, whereas the strategic, cross-regional nature of central SOEs' operations leads to constraint softening. These differences manifest in distinct behavioral logics when responding to energy conservation regulations: local SOEs operate under combined political and market logics, central SOEs balance national strategic and economic logics, while private enterprises primarily follow market and technological logics in their responses.

The findings also extend and refine the Porter Hypothesis in several important dimensions. While Porter's framework emphasizes the coercive power of environmental regulations in driving energy conservation, this study reveals that market-based mechanisms (such as green finance and marketization levels) significantly amplify policy effectiveness, suggesting that institutional pressures achieve maximal impact only when combined with market incentives. This restructures our understanding of institutional environments' incentive architectures and implies a virtuous "policy-creates-markets, markets-reinforce-policies" feedback cycle, thereby expanding the Porter Hypothesis' applicability boundary. The study also identifies critical implementation challenges—ceremonial adoption may emerge when enterprises respond to top-down policies like NEDCC through superficial conformity rather than substantive behavioral changes, particularly under pure administrative mandates. Future research should investigate incentive-compatible regulatory designs, such as dynamic subsidy mechanisms and performance-linked rewards, to better understand how pilot policies can more effectively promote corporate energy conservation. Additionally, promising research directions include developing a "policy-market-firm" tripartite interaction model to analyze how different policy instruments influence firms' internal resource allocation strategies, ultimately leading to optimized energy consumption structures and reduced energy intensity.

6.3. Practical Implications

For governments, it is advisable to continue promoting the development of new energy demonstration cities, refining pilot experiences and forming exemplary cases to further drive the nationwide expansion of such initiatives. During the implementation of pilot programs, governments should exercise effective supervision and guidance over pilot cities to enhance the binding effect of policies. For enterprises of different types, a tiered approach should be adopted to precisely align with industry and enterprise characteristics. For instance, high-energy-consuming industries such as manufacturing and power generation should be subject to stricter green technology standards and provided with subsidies for technological upgrades. For service sectors like IT and logistics, efforts should focus on strengthening the construction of smart energy management platforms and promoting digital infrastructure. Small and medium-sized enterprises (SMEs) should be granted dedicated green loans to lower financing barriers. Additionally, market-based tools should be reinforced, such as expanding the coverage of carbon markets (e.g., including building materials and transportation) to enhance price signals, and promoting a combination of "green finance + policy" measures. To prevent symbolic compliance, a long-term regulatory mechanism should be established—for example, adopting blockchain-based energy data certification to ensure the authenticity of corporate disclosures, and implementing a "post-subsidy" mechanism that ties a portion of subsidies to subsequent energy efficiency improvements.

Enterprises should actively leverage the financial support provided by green finance to increase investment in green technology innovation, proactively developing and adopting new energy technologies, energy-saving technologies, and others. Through green technology innovation, enterprises can not only reduce energy consumption but also enhance market competitiveness. Large enterprises should consider green M&As as a key strategic tool for achieving green transformation, enabling them to quickly acquire clean technologies by acquiring firms with green technologies and resources. Enterprises should also actively advance digital transformation, utilizing smart technologies to optimize production processes and energy management. Through digitalization, they can improve production efficiency, reduce energy costs, and achieve green and sustainable development. Particularly for SMEs, lightweight digital transformation can be realized by leveraging industrial internet platforms, or by adopting energy digital management systems available for rent in the market.

6.4. Limitations and Future Research

While this study provides robust evidence on the impact of the NEDC policy and explores heterogeneity across key dimensions such as ownership, industry, and energy type, it inevitably has limitations that point to fruitful avenues for future research. First, our measure of corporate energy consumption, while constructed from disclosed data, may be subject to reporting heterogeneity across firms. Several promising layers of heterogeneity remain unexplored, such as differential responses within the central state-owned enterprise sector, the interplay between energy intensity and consumption of specific energy types like electricity, and the distinct behaviors of construction-oriented versus operation-oriented firms within broad industry classifications. A more focused inquiry into any of these areas, perhaps employing advanced firm-level classification or qualitative case studies, would deepen our understanding of the micro-mechanisms through which environmental policies shape corporate behavior.

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